

**SECTION 15502**  
**MAKE-UP AIR HANDLING UNITS - CLEANROOM**

**PART 1 - GENERAL**

**1.1 Related documents**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Section, apply this section.

**1.2 Related Sections**

- A. This Section specifies the requirements to furnish and install horizontal airflow 100 percent outside air handling units as specified with the capacities, performance, and dimensions shown on the contract drawings and, suitable for supplying air to a controlled cleanroom environment.
- B. Work to be provided under this division includes supplying, receiving, unloading, handling, erecting, installation, testing, and start-up of material and equipment required for mechanical systems, complete in all respect as required by the contract documents.
- C. The equipment specified in this Section is intended to assist in achieving a controlled Cleanroom environment. All materials, equipment, and fabrication methods shall be directed toward this objective. Care shall be used in the avoidance of paints, gaskets, seals, sealants, and other materials, which outgas. Where outgassing is unavoidable, clearly identify products and base materials in all submittals. Substitutions of outgassing materials for materials of a different base content shall be provided at the Owner's request.
- D. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced air-handling units.
  - 1. Section 15050 – Piping Systems.
  - 2. Section 15055 - Motors.
  - 3. Division 15, Section 15106, "Chilled Water, Condenser, Water, Cooling Tower Water, Heating Hot Water, Condensate & Process Water Piping, including Hydronic Specialties".
  - 4. Division 15, Section 15887, "HVAC Air Filters and components."
  - 5. Division 15, Section 15990, Testing, Adjusting, and Balancing."
  - 6. Division 16, Section 16441, "Disconnect Switches."
  - 7. Division 16, Section 16483, "Motor Control."
  - 8. Division 17, Section 17050, "I & C Basic Materials and Methods."
- E. In the event of conflict regarding requirements for the referenced air-handling units between this section and any other section, the most stringent provisions shall govern.

**1.3 References**

- A. All products, materials, and installations included under this section shall adhere to and comply with all applicable codes, standards, ordinances, and regulations. Include with product data, information that certifies compliance with the following as applicable:

1. ANSI/AMCA 210-99, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
2. AMCA Standard 300-96, Reverberant Room Method for Sound Testing of Fans
3. ANSI/ARI 410-01, Forced-Circulation Air-Cooling and Air-Heating Coils
4. ANSI/ARI 430-99, Central Station Air Handling Units
5. ASTM A653-01, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
6. ASTM A167-99, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
7. ASTM B209-01, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
8. NFPA 70, National Electrical Code
9. NFPA 90A, Standard for the installation of Air conditioning and Ventilating Systems
10. AMCA 210, "Laboratory Methods of Testing Fans for Ratings
11. AMCA 500 – (1991) Louvers, Dampers and Shutters
12. UL-555S – (1996) Leakage Rated Dampers for Use in Smoke Control Systems
13. UL-916 – (1994; "bulletin 1994 and 1996, R 1996) Energy Management Equipment
14. UL 1995 – (1995) "UL Standard for Safety Heating and Cooling Equipment".

#### 1.4 Submittals

- A. General: Submit each item in this Article for approval according to the conditions of the Contract and General and Supplementary Conditions.
- B. Product Data for each HVAC equipment listed in Section 1.2 and shall include the following:
  1. Certified fan-performance curves with system operating conditions indicated.
  2. Certified fan-sound power ratings.
  3. Certified coil-performance ratings with system operating conditions indicated.
  4. Motor ratings and electrical characteristics plus motor and fan accessories.
  5. Material gages and finishes.
  6. Filters with performance characteristics.
  7. Dampers, including housings, linkages, and operators.
  8. Smoke Detectors.
  9. Equipment roof curb for flat equipment installation on sloping roof. Submit curb support details for A/E approval
- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, and methods of field assembly, components, and location and size of each field connection.
- D. Wiring diagrams detailing wiring for power and control systems, control interface differentiating between manufacturer-installed and field-installed wiring.
- E. Coordination Drawings, including floor plans and sections drawn to scale. Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- F. Field test reports indicating and interpreting test results relative to compliance with specified requirements.
- G. Operating and Maintenance data: For air-handling units are to be included in the Operation and Maintenance (O&M) manuals as specified in General and Supplementary Conditions and Division 15 requirements.

## 1.5 Quality insurance

- A. NFPA Compliance: Air-handling equipments and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- B. AMCA Compliance for centrifugal fans: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to the applicable portions of ARI 430, "Central-Station Air-Handling Units," and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute (ARI).
- D. UL and NEMA Compliance: Provide motors required as part of air-handling units that are listed and labeled by UL and comply with applicable NEMA standards.
- E. Comply with NFPA 70 for electrical components devices and accessories installation.
- F. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code (NEC), Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulations 1910.7.
- G. Coordination: Coordinate layout and installation of central-station air-handling units with piping and ductwork and with other installations.
- H. The buyer/owner or his representative shall maintain the right to tour the manufacturer's plants at any time that fabrication is being performed on components intended for this Project.
- I. The manufacturer shall notify the buyer/owner when production is finished on the first component of each type. Any time after that date, the buyer/owner may exercise the option, without advance notice, to tour the plant and inspect for component assembly, painting, cleaning, or packaging to ensure that quality control is being maintained.

## 1.6 PRODUCT HANDLING, DELIVERY AND STORAGE

- A. Shipping: Where possible for shipping and installation, units shall be shipped fully assembled. Where units must be shipped in sections, units shall ship in the fewest number of sections to meet project requirements. Each section shall be prepared as follows:
  - 1. The entire fan unit, casing, and other accessories with contact to clean air shall be preliminarily cleaned in the factory after final assembly with 10 percent isopropyl alcohol (IPA), 90 percent DI water, and industrial cleaning fluids to remove all oil, residue, and dust. After the unit has been cleaned, shrink wrap in a non-PVC protective plastic bag 5 mils thick and heat seal all joints. After shrink wrap, the unit shall be wrapped and sealed in a Visqueen sheet prior to movement onto framing members. The wrapping shall provide protection so that the unit can be transported and stored without contamination of the cleaned unit.
  - 2. Each cleaned and bagged unit shall be strapped on top of a full-sized wood base constructed of a minimum 4-inch by 4-inch framing members to allow shipment and handling, without damage to the casework. Shipping base and pallet frame shall be suitable for forklift pickup and moving. The outside of the package or crate shall be

adequately marked or tagged to indicate its contents, including equipment name, contract name and number, approximate weight, any special precautions for handling, and recommended requirements for storage prior to installation.

- B. Final Cleaning Method: This procedure shall be followed upon completion of all field installation to occur within the unit. Remove all adhesives and manufacturing residue with IPA or other solvents using a low-lint cotton Cleanroom wiper. Any solvents used other than IPA must be approved in advance, and any areas cleaned with these other solvents must be re-cleaned with IPA. Vacuum all exterior surfaces first from top working to the bottom. Follow by vacuuming the interior surfaces, again top toward bottom. Vacuum shall be cleanroom compatible HEPA-filtered type, or house vacuum with exhaust outside the cleaning area. Portable units shall be outside the cleaning area, with extended hoses. Follow vacuuming with cleaning of exterior and interior with cleaning solution. The exterior shall be cleaned first, from top working to bottom. Exterior cleaning of units installed on roofs shall consist of pressure washing for removal of construction and atmospheric dirt. After exterior cleaning, clean the interior, top surfaces first, followed by the sides and then the bottom. Cleaning shall be performed with PVA cleanroom sponges, with cleaning solutions contained in stainless steel working containers. Use polyester wipes for drying. Only distilled water shall be used to dilute cleaning solutions and to rinse sponges. Solutions and water shall be changed as soon as they are visibly dirty. Sponges shall be changed when the outer surface becomes abraded. Following cleaning, the unit shall be first 100 percent visually inspected for contamination. Next the units shall be wipe-tested in a minimum of three locations on each subassembly. No dirt shall show on the cleanroom wipe after three circular wipes of an approximate 1 square-foot area of each tested location. Areas failing the wipe test shall be re-cleaned.
- C. Delivery: Receive and unload air handling units to installation site. Owner and Contractor shall inspect air-handling units when they are received and immediately report any damage or shortage. Any units arriving at the installation site damaged beyond field repair to new condition shall be rejected and must be returned to the manufacturer for rework or replacement.
- D. Storage: Air handling units, which cannot be installed immediately after delivery shall be stored in a safe, dry location as directed by the Owner.

## 1.7 Extra Materials/Spare Parts

- A. Provide two sets of filters and belts for each unit.

## 1.8 Sequencing and Scheduling

- A. Coordinate size and location of concrete housekeeping bases. Drill concrete expansion anchors into base. Anchor points in accordance with manufacturers' instructions.
- B. Coordinate size and location of structural-steel support members.

## PART 2 - PRODUCTS

### 2.1 General

- A. Acceptable Manufacturers:
  - 1. Pace Division/York International
  - 2. Huntair
  - 3. Cleanpak

4. Air Enterprises
  5. Approved equal
- B. Units shall be constructed and shipped in modules suitable for receipt through 7'-6" wide by 8'-0" high dock doors. Modules shall bolt together with thermal break construction. Modules shall be supplied with a longitudinal galvanized steel structural perimeter base section that shall serve as a housekeeping rail when unit is installed. Perimeter lifting lugs for overhead lifting shall be provided. Each section of the unit base shall contain a minimum 1-inch NPT drain to facilitate system wash-down. All drains shall be sealed with threaded caps secured to the unit base with chains.
- C. Structural perimeter base shall be sized to allow for sufficient height to field install a condensate trap between the condensate drain pan outlets and the bottom of the base. The distance from the bottom of the drain connection to the bottom of the unit base shall be sized as follows:
1. Draw through units:  $[\text{Negative static pressure at drain}] \times 1.5 + 3"$
  2. Blow through units:  $[\text{Positive static pressure at drain}] \times 1.5 + 3"$
- D. All components downstream of the first cooling coil section shall have no-through-metal thermal break construction. The entire unit shall be designed to eliminate any condensation on the outside of the unit during design operating conditions.
- E. Galvanized materials shall be treated with cold galvanizing organic zinc-rich coating containing 95% metallic zinc, by weight in the dried film to prevent rusting at all broken or sawed edges.
- F. Insulation Requirements: NFPA 90A, flame spread rating not over 25 and smoke developed rating not higher than 50.

## 2.2 Casing

- A. Units shall be constructed of sectionalized heavy-gage, mill galvanized steel or aluminum formed panels, rigidly reinforced. Bolts and screws shall be stainless steel or aluminum rivets. Casing panels shall be removable for easy access to the unit.
- B. Panels shall be double wall construction with 16 gauge galvanized steel or aluminum inner and outer liner. Unit outside shall be finished in manufacturer's standard baked enamel finish. Panels shall be insulated with 6-lb. density neoprene coated glass fiber insulation which shall be secured to casing with waterproof adhesive and permanent fasteners and shall meet NFPA-90A flame spread and smoke generation requirements. Insulation shall have a minimum effective thermal resistance ("R" value) of 4.0 (degrees F ft<sup>2</sup> h/btu-in). Bolts and screws shall be stainless steel.
- C. Minimum casing thickness shall be 2 inches for indoor units and 4 inches for outdoor units.
- D. The entire unit base shall be fully welded, waterproof, and designed as a minimum 3-inch deep sump. The sump shall be double sloped towards the unit drains. The floor shall be designed for a minimum live load of 100 pound per square foot throughout the unit.
- E. Provide 316L stainless steel inner liner, floor and ceiling panels in complete humidifier section. A 316L stainless steel, 4-inch-deep, double sloped, welded drain pan shall extend throughout the entire humidifier section.

- F. All unit base openings shall be framed with a minimum 2-inch high water dam continuously welded to the floor. Framed openings shall be provided with removable galvanized grating designed and fabricated for a live load of 100 pounds per square foot.
- G. Access doors shall be of double wall construction and be installed on lift-off type stainless steel hinges for all outward opening applications. Hinge pins shall be welded to base plate. Multiple handles shall be provided. Handles shall be epoxy coated or stainless steel and rated to meet 500-hour salt spray requirements. Internal latches shall be stainless steel. Provide minimum size 10-inch x 10-inch tempered glass, 1/4-inch double pane window with desiccant in air space. Doors shall open against pressure and clear all internal and external components. Access doors must have thermal break construction and shall be designed to eliminate any condensation on the outside of the unit during design conditions.
- H. All penetrations through unit casing for piping, conduit, and miscellaneous control devices shall be sleeved in galvanized steel and sealed. Unit manufacturer shall coordinate locations with Subcontractor as shown on figures, indicate on shop drawings, and seal all factory-mounted accessories.
- I. Outdoor units shall be designed for such duty with weatherproof construction, sloping roofs, eyebrows over access doors, rainproof drainable intake louvers, and provisions for curb mounting.
- J. The unit casings shall have been tested for acoustical performance by an independent laboratory that is accredited.
  - 1. Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73.
  - 2. Sound Transmission Loss DB ASTM E-90 and E413-73:

Octave Band Frequency (Hz)	125	250	500	1000	2000	4000	
Transmission Loss (DB)	26	29	33	44	52	60	STC38
Radiated SPL@ 3ft dist.	81	74	57	42	40	40	66 DBA

### 2.3 Fan Section

- A. Provide galvanized steel construction framed channel base for integral mounting of fan, motor and casing. Fan wheel, shaft, bearings, drives, and motor shall be mounted on a structural steel assembly which shall be isolated from the outer casing with factory installed 2-in. deflection spring isolators and vibration-absorbent fan-wall seal. Internally mounted motor shall be factory installed on slide rails having 2 adjusting screws. Provide a removable panel, of adequate size to permit removal of the fan wheel, motor and drive.
- B. Fans shall be direct-drive plenum or plug style, with backward curved airfoil section blades. Wheels shall be continuous welded all aluminum construction. Provide wire mesh protective wheel enclosure and heavy gauge wire inlet screen.
- C. For dual fan arrangements, each fan shall have an isolation damper mounted on the upstream side of the fan intake wall to isolate one of the fans for servicing while the second fan continues to operate.
- D. Fan wheels shall be keyed to shaft and be designed for continuous operation at the maximum rated fan speed and motor horsepower. Select fans and shafts to operate at least

25% below the first critical speed. Fan wheels and shafts shall be statically and dynamically balanced as an assembly. After final assembly, the entire unit shall be given final vibration test.

- E. Bearings shall be self-aligning, pillow block re-greaseable ball types selected for an average life (AFBMA L-50) of 200,000 hours at design operating conditions. Bearings shall be equipped with Zerk fittings and lubrication lines extending through the unit casing. Shafts shall be solid steel, turned, ground and polished.
- F. Motors shall be of voltage as shown on contract drawings, high efficiency type, for use with a Variable Frequency Drive. The fan motor shall be TEFC or TEO with a minimum service factor of 1.15.
- G. Variable frequency drive (VFD) provided by others. Provide conduit and conductors from fan motors to VFD mounting location if VFD is mounted on unit or through casing for remote VFD mounting.
- H. Provide airflow measuring station for supply, outside air and return air as indicated on control diagrams with signal transmitter mounted on exterior of unit casing.

#### 2.4 Coils

- A. All coils shall be of the cartridge type, removable from coil connection side of casing and supported in tracks over the entire length of the coil.
- B. Coil sections shall have heavy-duty coil tracks extending the full width of the unit to provide slip-in, slip-out coils for ease of service and maintenance.
- C. Cooling coil condensate drain pans shall have double wall, double sloped construction with threaded drain connections on both sides and shall extend under the complete long coil section of the units. On single coil horizontal draw-through units with short coil sections, drain pan shall extend under complete fan and coil section. Insulate condensate drain pan with 0.6-in. thick isocyanurate foam faced with an additional aluminum foil vapor barrier and cemented between the steel outer pan and heavy gage stainless steel inner pan. Inner pan shall be coated with corrosion-resistant elastomeric based material. Insulation, adhesive and inner coating shall comply with NFPA-90A flame spread and smoke generation requirements.
- D. Where cooling coils are stacked, provide 4-inch-deep stainless Type 316 steel intermediate drain pans at maximum vertical 36-inch intervals with 2-inch drain pipe connections on each end. Drain pipe leaders shall be either stainless Type 316 or PVC with stainless steel fasteners.
- E. Chilled water and hot water coils shall be aluminum plate fins mechanically bonded to minimum 1/2" seamless copper tubing 0.02" minimum wall thickness. Headers shall be seamless copper with brazed coil connections. Coils shall be tested with 315 pounds air pressure under warm water and shall be suitable for operation at 250 psig working pressure. Coils shall be constructed for drainability. Casing shall be constructed of continuous galvanized steel compatible with slip out configuration. Provide alternate pricing for stainless steel casings.
- F. Provide Dwyer Magnahelic Gauge complete with static pressure tips and accessories for indicating operational pressure drop of each coil section. Gauges shall be mounted flush on outside of unit casing.

## 2.5 Air Filters

- A. Air filters shall be provided with the unit. Minimum two sets of filters shall be provided: One set for construction phase, one set for system operation, second set of filters shall be installed after all ductwork is installed, cleaned and tested, and prior to final balancing.
- B. Provide filters of make, size, arrangement, and efficiencies as indicated on drawings and as defined in Section 15887, HVAC Air Filters and Components.
- C. Provide filter holding frames of minimum 16-gauge galvanized steel with vertical stiffeners, continuous gasket seal flange, and fasteners. Filter frames shall be installed and sealed to prevent any air leakage or bypass around the frames and arranged for front loading of the filters from the entering air plenum side.
- D. Provide Dwyer Magnahelic gauge complete with static pressure tips and accessories for indicating the operating pressure drop of each filter bank. The indicating range of the gauge shall be selected at twice the final resistance of the filter bank. Gauge shall be mounted flush on outside of unit casing.

## 2.6 Humidification Section

- A. For the Target Building only, provide as indicated on drawings, a suitable length of (84" unless otherwise indicated) access-segment for "Fogger-Humidifier" installation within the Air handler housing in the field. Access-segment shall include a moisture-separator section to prevent water carry-over in the supply air stream.
- B. Furnish a complete Fogger Humidifier assembly shipped loose with the Air Handling Unit ready for installation with minor modifications to the access-segment housing. Air Handling Unit manufacturer shall coordinate modular housing length requirements prior to assembly with Fogger-Humidifier manufacturer recommendation to achieve proper water dispersion within the added space.
- C. Fogger Humidifier assembly shall be installed by the Mechanical Contractor in the field, under the Air Handling Unit manufacturer 's supervision and start-up assistance such that all warranties are maintained.
- D. Factory fabricated assembly shall include: manifolds, tubing, fittings, nozzles, stainless-steel drain pan, control panel(s) and all required proportional controls.
- E. Materials of construction for all wetted parts shall be compatible for low conductivity, deionized-water use.
- F. Water and air pressure to disperse deionized (DI) water shall be provided by others, as indicated on drawings.
  - 1. Evaporation efficiency shall not be less than 98%, prior to impinging upon any surface within the fog chamber while delivering its maximum rated capacity of fog with water supplied at 75 PSIG (to the control panel) and 95 PSIG compressed air (to the control panel). Humidification (fogging) capacities shall be no less than amounts indicated in the respective humidification schedule for each air handling system.
  - 2. Equipment: Fogger manifolds shall be furnished complete for installation & consist of:
    - a. Resonator assembly, which permits online pattern adjustment from doughnut to plume to achieve cross flow mixing with the receiving air mass, shall be of one piece and made of 316 Stainless steel. There shall be no moving parts on the resonator assemblies.



- b. Orifice shall be interchangeable and made of 316 Stainless steel, capable of generating a pound of fog for each 0.10 SCFM of compressed air consumed at maximum scheduled humidifier capacities. Orifice and resonator shall be capable of maintaining an ultrasonic field at driving air pressures above 20 PSIG.  
The entire assembly shall have a "linear-modulation" characteristic such that as air and water pressures are modulated in parallel, the water droplets are continually reduced to 0.10 to 10.00 micron particles, even as flow for each respective fluid is changed through the action of the air and water modulating valves.
- c. All "fogger-head" and related integral components shall all be constructed of 316 Stainless Steel.
- d. Check valve: Fogging assemblies shall be equipped with a dedicated water check valve with a minimum cracking pressure capability at 0.33 PSIG.
- e. Fogger-manifold: Each manifold shall be factory assembled and shall have a secondary water line for pressure stabilization, which shall run parallel to the main water line on each manifold. All manifold fittings shall be 316 SS tube fittings.
- f. Water and Air Control valves: Deionized water and Compressed Air control valve assemblies shall be factory pre-assembled by the fogger-humidification equipment manufacturer.  
Each water system shall be equipped with a dedicated, 1/4" size, capacity modulating water valve. Valve shall be ball type, 316 Stainless Steel as manufactured by Jordan. Model MK 68-8 or approved equal.  
Each compressed air valve assembly shall have a dedicated, 1/4" size, 3-way actuated air valve for positive shut-off and drain-down of water when the system is off. Valve shall be ball type, 316 Stainless Steel as manufactured by Whitey, Model 43XF4-31C-1303 or approved equal.
- g. The resonator plug and stand shall permit realignment and replacement without removal or replacement of the fogger assembly.
- h. The fogger must have no moving parts. Any fogging device with springs or diaphragms is unacceptable.
- 3. Local Control Panel: Control panel shall be factory fabricated, NEMA 4, with all fittings for field connection suitably tagged and include the following:
  - a. Will wiring connections shall be numbered on a pre-wired terminal strip.
  - b. The panel shall house both regulating and proportional valves as well as the operating safeties and controls, which make the system fully automatic.
- 4. Local Panel Connections:
  - a. Air and water, supply and outlets.
  - b. 120 volt operating circuit.
  - c. 24 or 120-volt circuits to remote valves and sensors.
  - d. DDC control signal interface for trouble alarm.
- 5. Panel Indicators:
  - a. Power on light.
  - b. Foggers on light.
- 6. Panel Operations:
  - a. On/Of switch.
  - b. Remote Air Feedback (RAF).
- 7. Remote Air Feed Back (RAF):
  - a. The Remote Air Feedback (RAF) system shall continuously monitor the downstream remote air pressure at the fogger manifold(s) within the fog chamber. The RAF is read by the signal-air biasing relay within the panel and maintains a fixed pressure differential between the air and water valves. The biasing relay is set so that a fixed pressure differential is maintained at the fogger throughout the systems' operational range.

- b. Modulation of both air and water is required. Both compressed air and water shall have their own modulating valve. The pressure differential between the compressed air and water must be constant throughout the entire modulating range. Each system shall have a modulating range of no less than 50 to 1.
- 8. Humidifier Manufacturer shall be Armstrong / "Cool-Fog" or equal.

## 2.7 Automatic Dampers

- A. All damper blades shall be double skin galvanized steel air foil type, housed in a galvanized steel frame and mechanically fastened to a hex axle rod rotating in stainless steel bearings. Stainless steel jamb seals and neoprene blade seals are required. All dampers shall be rated for a maximum leakage rate per square foot of 4 CFM at 1.0 inch and 8 CFM at 4.0 in wg or better.
- B. Smoke dampers shall be UL 555S classified and labeled, multiblade assembly with frame and airfoil blades with silicon rubber blade seal. Damper shall be leakage class I.
- C. Damper blade interconnection mechanisms shall be contained within the damper frame and not subjected to the airflow path. Interconnection linkage shall provide positive blade-to-blade interaction without slippage. Linkage mechanism shall be stainless steel or Teflon coated to prevent corrosion and ensure smooth operation.
- D. Dampers exceeding 16 square feet shall be constructed in multiple equal-size sections. Operate each section by a separate actuator of size and capacity suitable for the damper provided with the MUA package not pilot operated. Damper actuator shall be pneumatic.
- E. Damper end shafts shall be a minimum of 18 inches long. Shaft length shall be of sufficient length to provide proper attachment to the damper drive blade without slippage. Shaft extension shall be adjustable from 3 inches to 12 inches outside the damper frame and air-handling unit case.

## 2.8 Accessories

- A. Plenum sections shall be suitable for installation between any 2 components to provide a transition space between sections, except the one-coil high short coil sections. All service plenums shall be fitted with manually opened, hinged, full-height access doors, interior lights, exterior light switch, and 120V outlets.
- B. Each unit shall have all light circuits and outlets connected to and served from a single junction box. Minimum conductor size shall be 12 AWG. All conductors shall be copper. Provide a minimum of one light per section and two separate lights in the humidification and fan motor sections. All lights shall be common circuited to three-way switches, open each end of unit.
- C. Weatherproof Vestibule:
  - 1. Where indicated on the contract drawings, provide a weatherproof vestibule totally or partially enclosing the side of the air handler. Vestibule shall be integral with the air handler or attached with a weatherproof, gasketed connection. Vestibule shall be fitted with manually opened access door. Provide interior fluorescent lights, wiring, conduit and switches.
  - 2. Vestibule roof support structural members and their respective vertical supports shall be designed for support of interior piping and to withstand seismic loads imposed by piping. Piping penetrations through exterior vestibule walls shall be round, pre-punched at the factory, and sized for 1-inch gap around piping insulation.

3. Vestibule shall be of the same material used for the casing. Outdoor walls, roof, and floor shall have a minimum thermal resistance of R-11. Insulation shall be protected from damage. Provide minimum 1/4-inch diamond plate, painted or galvanized, nonskid surface for floors of vestibules. Diamond plate floors shall be fastened with flush fasteners. Flooring system shall be gasketed to provide a waterproof floor. Provide 3-inch-high curbs around pipe openings in the floor of vestibules. Other protrusions above the floor that may cause a person to trip are prohibited.

## PART 3 - EXECUTION

### 3.1 Examination

- A. Examine areas and conditions to receive equipment, for compliance with installation tolerances and other conditions affecting performance of central-station air-handling units.
- B. Examine roughing-in of steam, hydronic, condensate drainage piping, and electrical to verify actual locations of connections before installation.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install in strict accordance with manufacturers requirements, shop drawings, and Contract Documents.
- B. Install until flat and align with dedicated roof curb. Curb support and anchoring to roof shall meet the building seismic category performance.
- C. Arrange piping for easy dismantling to permit tube cleaning.
- D. Furnish and install necessary piping as applicable.
- E. Coordinate electrical installation with electrical contractor.
- F. Coordinate controls with controls contractor.
- G. Provide all appurtenances required to ensure a fully operational and functional unit.

### 3.3 Housekeeping bases (Not Applicable, all units mounted on roof curbs.)

### 3.4 Connections

- A. Piping installation requirements are specified in other Division 15 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specified connection requirements:
  1. Install piping adjacent to machine to allow service and maintenance.
  2. Connect condensate drain pans using 1-1/4 inch NPS (DN32), Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
  3. Hot- and Chilled-Water Piping: Conform to applicable requirements of Division 15 Section 15106, "Chilled Water, Condenser, Water, Cooling Tower Water, Heating Hot Water, Condensate & Process Water piping, including Hydronic Specialties." Connect to supply and return coil tapings with shutoff or balancing valve and union or flange at each connection.

4. Refrigerant Liquid (RL) and Refrigerant (gas) Suction (RS) tubing specification connecting Outdoor and Indoor AC units shall be as per Section 15125, "DX Refrigerant piping System & Accessories."
  - B. Duct installation and connection requirements are specified in other Division 15 Sections. The Drawings indicate the general arrangements of ducts and duct accessories. Make final duct connections with flexible connections.
  - C. Electrical: Conform to applicable requirements of Division 16 Sections.
    1. Connect fan motors to wiring systems and to ground. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. When manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
    2. Temperature control wiring and interlock wiring is specified in Division 17.
    3. Temperature control wiring and interlock wiring for the Center for Nanophase Materials Science (CNMS) is specified in Division 15, Section 15950 "Direct Digital Control System."
- 3.5 Adjusting
- A. Adjust damper linkages for proper damper operation.
- 3.6 Cleaning
- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
  - B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- 3.7 Commissioning
- A. Manufacturer's Field Inspection: Engage a factory-authorized service representative to perform the following:
    1. Inspect field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
    2. Prepare a written report on findings and recommended corrective actions.
  - B. Final Checks before Startup: Perform the following before startup:
    1. Verify that shipping, block, and bracing are removed.
    2. Verify that unit is secure on mountings and supporting devices and those connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
    3. Perform cleaning and adjusting specified in this Section.
    4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
    5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
    6. Set zone dampers to fully open position for each zone.
    7. Set face-and-bypass dampers to full face flow.
    8. Set outside-air and return-air mixing dampers to minimum outside-air setting.
    9. Comb coil fins for parallel orientation.
    10. Install clean filters.

11. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.
- C. Starting procedures for central-station air-handling units include the following:
  1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
    - a. Replace fan and motor pulleys as required to achieve design conditions.
  2. Measure and record motor electrical values for voltage and amperage.
  3. Manually operate dampers from fully closed to fully open position and record fan performance.
- D. Refer to Division 15, Section 15990 "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

### 3.8 Demonstration

- A. Engage the services of a factory-authorized service representative to train operating and maintenance personnel as identified by the Construction Manager (CM) on procedures and schedules related to operations, startup, shutdown, troubleshooting, servicing and preventative maintenance.
  1. Review data in the Operation and Maintenance (O&M) manuals. Refer to closeout requirements in General and Supplementary General Conditions.
  2. Schedule training with Construction Manager (CM), with at least 7 days' advance notice.

**END OF SECTION 15502**